

DEMULSIFICATION OF CRUDE OIL EMULSIONS VIA MICROWAVE ASSISTED
CHEMICALS (ENVIRONMENTAL FRIENDLY)

by

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ABSTRACT

Demulsification is a process of emulsion breaking. It is important in industry application such as waste water treatment, refinery and painting industry. Microwave and chemical heating is the most widely used method of water in oil demulsification. In this research, the combination of microwave and chemical is used to increase the efficiency of water in oil demulsification. To prevent the environmental issues, natural chemical is used in this research which is Diethanolamide of coconut fatty acid. The effectiveness of microwave assisted natural chemical in demulsification was assessed experimentally with two different power of microwave which are 450 and 600, and two different concentration of Diethanolamide of coconut fatty acid which are 0.5% and 1.5%. The water in oil emulsion was prepared by using artificial emulsifier. Artificial emulsifiers used are Triton X-100, Low Sulphur Wax Residue (LSWR) and Span 83. The natural chemical (Diethanolamide of coconut fatty acid) were added in the emulsion to increase the performance before heating the emulsion with microwave. The result shows that demulsification by using microwave assisted natural chemical was faster and more environmental friendly compared to conventional method.

ABSTRAK

Demulsifikasi adalah proses pemecahan emulsi. Proses ini amat penting di dalam applikasi industri seperti rawatan air sisa, penapisan dan industri lukisan. Pemanasan gelombang mikro dan kimia adalah kaedah yang banyak digunakan untuk proses demulsifikasi air dalam minyak. Dalam kajian ini, gabungan pemanasan gelombang mikro dan kimia digunakan untuk meningkatkan prestasi demulsifikasi air dalam minyak. Untuk mengelakkan isu-isu alam sekitar, bahan kimia yang digunakan di dalam penyelidikan ini adalah bahan kimia semula jadi iaitu Diethanolamide dari asid lemak kelapa. Proses gabungan pemanasan gelombang mikro yang dibantu oleh bahan kimia semula jadi ini telah diuji kaji dengan dua kuasa gelombang mikro iaitu 450 dan 600 seta dua kepekatan bahan kimia Diethanolamide dari asid lemak kelapa yang berbeza iaitu 0.5% dan 1.5%. Emulsi air dalam minyak telah disediakan dengan menggunakan pengemulsi tiruan. Pengemulsi tiruan yang digunakan adalah Triton X-100, Sulphur Rendah Wax Residu (LSWR) dan Span 83. Sebelum dipanaskan di dalam gelombang mikro, kimia semula jadi (Diethanolamide dari asid lemak kelapa) telah ditambahkan ke dalam emulsi air dalam minyak untuk meningkatkan prestasi. Keputusan yang diperolehi menunjukkan bahawa demulsifikasi menggunakan cara pemanasan gelombang mikro yang dibantu dengan bahan kimia semula jadi adalah lebih cepat dan mesra alam berbanding kaedah konvensional.

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LIST OF SYMBOLS

$\varepsilon'_{r,w}$	-	Dielectric constant of water
$\varepsilon''_{r,w}$	-	Dielectric loss of water
$\varepsilon'_{r,o}$	-	Dielectric constant of crude oil
$\tan \delta_o$	-	Loss tangent of crude oil
$q_{MW,z}$	-	The volume rate of heat generation
A	-	Convective heat transfer area, cm^2
V	-	Volume of irradiated emulsion, cm^3
T_m	-	Temperature of emulsion, $^{\circ}\text{C}$
T_a	-	Ambient Temperature, $^{\circ}\text{C}$
ε	-	emissivity of surface
σ	-	Stefan-Boltzmann constant= $5.672 \times 10^{-8} \text{ W/m}^2 \cdot \text{K}^4$
ρ	-	Density of emulsion, g/cm^3
C_p	-	Heat capacity at constant pressure, $\text{cal/g} \cdot ^{\circ}\text{C}$
$\frac{dT}{dt}$	-	Rate of temperature increase in $^{\circ}\text{C/s}$
ρ_m	-	Density of emulsion, g/cm^3
ρ_w	-	Density of water, g/cm^3
ρ_o	-	Density of crude oil, g/cm^3
$C_{p,m}$	-	Heat capacity of emulsion, $\text{cal/g} \cdot ^{\circ}\text{C}$
$C_{p,w}$	-	Heat capacity of water, $\text{cal/g} \cdot ^{\circ}\text{C}$
$C_{p,o}$	-	Heat capacity of crude oil, $\text{cal/g} \cdot ^{\circ}\text{C}$

Φ	-	Volume fraction of emulsified water
D_p	-	Penetration depth
c	-	Electromagnetic wave velocity = speed of light
f	-	Frequency
% water separation	-	Percentage of water separation

LIST OF ABBREVIATIONS

W/O	-	water-in-crude oil
O/W	-	crude oil-in-water
W/O/W	-	water-in-crude oil-in-water
LSWR	-	Low Sulphur Waxy Residue
Cocamide DEA	-	Diethanolamide of coconut fatty acid
HLB	-	Hydrophilic-Lipophilic Balance

CHAPTER ONE

INTRODUCTION

1.1 Background of the propose study

Petroleum is hydrocarbon compound containing others chemical which is nitrogen, sulfur oxygen, nickel and vanadium. Petroleum consists of two types which is crude oil and the condensate. Crude oil containing water is harmful to the transportation, refinery, and also decrease the quality of the products. Water in the crude oil is an emulsion, means, a system containing at least one liquid droplet is immiscible to another liquid medium. Thus, breaking of crude oil emulsion is a key

step in petroleum field. In addition, for economic and operational reason, it is necessary to break the emulsion or to separate the water from the crude oil. The process of separation of the water content from the crude oil emulsion is called demulsification. Reducing the water content in the crude oil can reduce pipeline corrosion and others equipment damage. Besides, there are two method approaches of demulsification. Those methods are chemical method and physical methods. The chemical methods is the addition of a demulsifier to the emulsion and physical method is using technique of heating, electrical, ultrasonic, and radiation. However, some of these methods will affect the environmental problem. Thus, in this research, method of microwave assisted chemical which is environmental friendly is applied.

1.2 Problem Statement

For economic purpose, pipeline consideration, and the quality of the product, the crude oil emulsion must be dewatered. The water contain in the crude oil emulsion may cause several operational problems. As a result, methods that can increase the efficiency, inexpensive, and shorten the time are needed.

1.3 Research Objectives

This research is guided by the following research objectives:

1.1.1 To study and understand the characterization of oil and aqueous phases

- 1.1.2 To compare the efficiency of demulsification of the crude oil emulsions between the conventional and microwave heating methods.
- 1.1.3 To study the preparation of crude oil emulsions and their characteristic
- 1.1.4 To evaluate microwave performance in demulsification of crude oil emulsions.

1.4 Scope of the Study

This research will only focus on the separation of water from the crude oil by using microwave assisted chemicals. In order to achieve the objectives, this research must be able to

- 1.1.5 Identifies the effect of the temperature heating using microwave
- 1.1.6 Identifies the effect of the chemical added in the emulsion
- 1.1.7 Determine the amount of water separation
- 1.1.8 Characterization of emulsions in term of physical three chemical properties
- 1.1.9 To identify temperature distribution of different locations for irradiations emulsions
- 1.1.10 To study the effect of varying the microwave power generation
- 1.1.11 To examine the demulsification of emulsions by microwave and conventional heating.

1.5 Expected Outcomes

In this research it is expected that the water separation from the crude oil is increasing by using microwave method and assisted chemical. This method will be applied in the petroleum field in order to solve the problems of pipeline corrosion, and produce good quality product.

1.6 Significance of the Study

Microwave method has drawn more attention compare to the conventional method as microwave give a clean (environmentally friendly) and efficient result. The used of heating, and electrical methods have disadvantages because it used a large amount of chemical (emulsifier) and environmental pollution. On the other hand, microwave assisted chemical is an economical methods.